Novel eco-friendly synthesis of neodymium doped zinc silicate phosphor based waste glass ceramic: structural, thermal and luminescence properties

ABSTRACT

A novel Nd^{3+} doped Zn_2SiO_4 (at Nd 2 wt%) phosphor have been synthesized at different sintering temperature (600–1000 °C) by low cost solid state route. For the first time, the eco-friendly based glass ceramic phosphor were produced by utilizing waste soda lime silica glass (SLS) and ZnO as precursor. The obtained samples were investigated in terms of thermal properties by DSC technique and the results showed a possible crystallization peak around 620 °C. The crystalline phase formation by XRD revealed α-willemite at lower temperature of 800 °C. The analysis by FTIR exhibit the existence of ZnO_4 and SiO_4 structural bonding. The microstructure analysis by FESEM revealed the evolvement from irregular blocks to crystalline structure. EDX analysis confirmed the presence of main element contained in the samples. UV–Vis spectroscopy shows absorption peaks from the ground $^4I_{9/2}$ state to various excited energy level of Nd^{3+} ion in $4f^3$ configuration. Under diode laser excitation of 800 nm photoluminescence, the samples shows possible upconversion emissions in the blue, green, orange and red region. Possible mechanism of upconversion were also studied proposing the suitability of Nd^{3+}:Zn_2SiO_4 based waste glass ceramic for solid state laser.

Keyword: Eco-friendly synthesis; Sintering temperature; Waste glass ceramic